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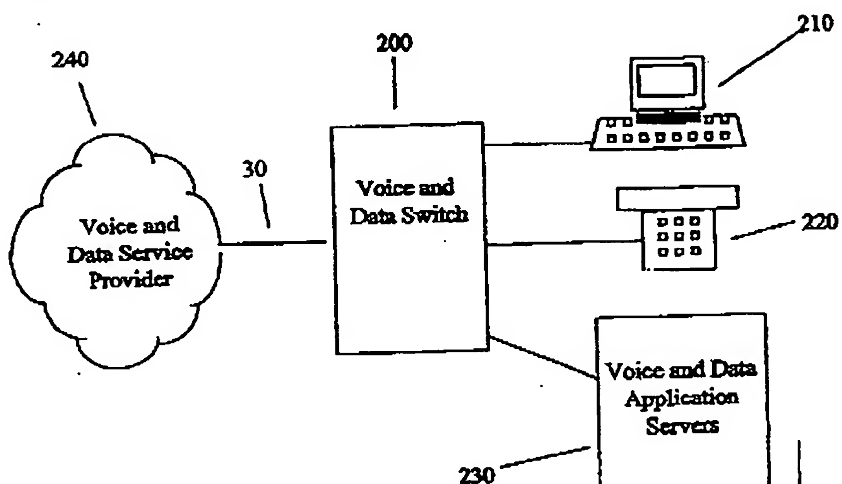

(57) Abstract

Methods and apparatus for integrating voice and data on a network including a key system unit; and a data module connected to the key system unit. The Data module is connected to the key system unit through a high speed interface and includes a microprocessor, a network controller connected to the microprocessor, a multi-port repeater connected to the network controller, and a WAN processor (bridge and/or router) connected between the repeater and the key system unit. The WAN processor is configured to communicate data received from the repeater to a data service provider through the key system unit and over the same trunk line which the key system uses to connect voice communications to a PSTN.

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METHODS AND APPARATUS FOR INTEGRATING VOICE AND DATA SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of applicants' copending U.S. patent application Serial No. 09/081,798, filed May 20, 1998.

FIELD OF THE INVENTION

The invention relates generally to the field of telecommunications and more particularly, to methods and apparatus of integrating voice and data on single system.

BACKGROUND OF THE INVENTION

In present business environments, voice only (i.e. telephone) communication networks are in the minority. Even in smaller businesses (hereinafter referred to as "small sites") such as branch offices of large organizations, regional or headquarter offices of multi-site organizations or enterprises (typically 20-30 telephones and above), small offices of larger or medium sized organizations or the offices of a small business (typically 2-20 telephones) Local Area Networks (LANs) and other data networking solutions are prevalent.

While larger business sites have the resources to continually maintain and upgrade separate voice and data networks, small sites do not generally have such ability. Therefor, integrating voice and data has the potential of providing significant benefits to end users, particularly at small site locations. Integrating voice and data networks will provide simplification, flexibility, and total cost of ownership reduction. While this could benefit all businesses, small site users in particular will benefit from the enhanced capabilities normally associated with larger sites. Further, due to their typical size and voice / data needs these small sites may be more suited to take advantage of service and equipment consolidation represented by integrated solutions.

There are few products in the integrated voice and data segment which address the needs of small site users. The models which are available can be grouped into

three basic categories: (1) LAN / server based solutions; (2) WAN consolidation solutions; and (3) total infrastructure solutions.

The LAN / server based solutions such as Selsius™ and Sphere™ systems and solutions based on technologies from Dialogic™ and Mitel™ place voice on the data networking and computing infrastructures via multiple components and platforms. Other LAN / server based solutions put the voice and data traffic over the Ethernet LAN and still others use the server concept, but these still have separate voice and data wiring infrastructures and components.

Voice over Internet Packet (IP) is an inherent piece of the LAN / server based systems since the voice is packetized into an IP protocol form and sent over the LAN between stations (which may be normal phones with PC interfaces or PC equipped with microphone / speaker / headset) or may be Ethernet phones (phones with Ethernet ports). WAN traffic can be sent via IP networks and the Internet or via interfaces to the Public Switched Telephone Network (PSTN). In order to implement these solutions, integration of the voice and data may be taking place on the same transmission media (always the data network media), these solutions still require discrete and separate components (voice servers, LAN hubs, routers, etc).

WAN consolidation solutions for integrated voice and data focus on consolidating WAN voice and data traffic on a common set of service or physical interfaces in order to reduce WAN service costs and increase flexibility in how WAN bandwidth can be used. In most cases, voice traffic directed over this integrated WAN link is private (between corporate sites) in nature since it is compressed and bundled into a form which is not currently compatible with the PSTN. Separate WAN links are often required to the PBX or Key System to provide PSTN connectivity. It should be noted that trends and standards are being put in place, such as H.323 and G.729 compression which will allow this type of traffic to be directed to public network gateways from data networks in order to facilitate PSTN connectivity and universal connectivity via data nets, however, it will be many years before these technologies are widespread and begin to make significant inroads into the PSTN as we know it today. In these products, some elements or components of the data networking solution are

integrated with the device providing the WAN integration. This is usually the data router and perhaps the LAN hub technology, but in almost all cases, the Key System or PBX providing the voice capabilities is a totally separate unit connected to the WAN consolidation device via expensive and unnecessary public interfaces. Voice compression and Voice over Frame Relay / ATM are technologies included in these solutions which are instrumental in delivering the WAN cost savings enabled by moving voice traffic over the WAN data network. Several examples of integrated solutions fitting this model are the Cisco™ 3800 / 3600 series of routers, the Micom Marathon / Magellan 4400 series of products from Nortel™, TDM and Statistical Multiplexers such as Adtran™ or Newbridge Mainstreet™ products and Vina-Technologies™ who introduced an Access Concentrator product in June 1997.

An interesting aspect of the Vina product is that rather than focusing on putting voice over Frame or ATM over the WAN, the unit consolidates voice and data traffic into a common T1, much like a TDM or Statistical multiplexer, and does not convert the voice into a packetized form. This enables all voice and data traffic to the small site to be put into a single physical T1 service interface without regard to whether the traffic needs to be redirected to the PSTN or a private network. The Vina solution, however, requires a service or Customer Premise Equipment (CPE) at the far end which can segregate and split the traffic into its data and voice components for delivery to the proper networks or devices at the far end.

There are currently no total infrastructure solutions on the marketplace which deliver a complete voice and data networking solution in a single package. A value of such a solution would be that it would deliver the WAN integration of the WAN solutions and consolidation of components into a single package which could greatly reduce interconnection and interworking issues as well as reducing higher total system cost driven by discrete elements. Accordingly, there exists a need for a total infrastructure solution which combines voice and data networking solutions.

There also exists a need for an integrated voice and data network which integrates components into a single package.

A need also exists for an integrated voice and data network which reduces

interconnection and interworking issues.

There is also a need for an integrated voice and data network which is inexpensive relative to the cost of the separate components.

Accordingly it is an object of the present invention to provide methods and apparatus of integrating voice and data on single network.

It is another object of the present invention to provide methods and apparatus of integrating voice and data on single system which integrates components into a single package.

It is a further object of the present invention to provide methods and apparatus of integrating voice and data on single system which is less expensive than having separate voice and data systems.

It is still another object of the invention to provide methods and apparatus of integrating voice and data on single system which reduces interconnection and interworking issues.

It is still a further object of the invention to provide a key system which integrates voice and data.

It is another object of the invention to provide a PBX which integrates voice and data.

It is yet another object of the invention to provide a total infrastructure solution which combines voice and data networking solutions.

These and other objects of the invention will become apparent to those skilled in the art from the following description thereof.

Summary of the Invention

In accordance with the teachings of the present invention, these and other objects may be accomplished by the present methods and apparatus of integrating voice and data on a network.

In an exemplary embodiment of the invention, the system includes an integrated voice and data network including a key system unit (KSU) and a data module connected thereto. The data module may include a microprocessor, a network

controller connected to the microprocessor, a multiport repeater connected to the network controller and, a WAN processor connected to the repeater and configured to communicate data received from the repeater to the KSU and a data interface in electrical connection with the microprocessor.

In another exemplary embodiment of the invention, the system include a data module which includes a media interface, a processor in electrical communication with the media interface, and a transceiver interface in electrical communication with the processor. The transceiver interface has a port configured for connection to data network equipment.

In still another embodiment, a data module is provided which is capable of connecting a data network to a key system unit. The data module includes a coupling module for coupling to a communication medium. It includes a processing module, connected to the coupling module, for processing data. It also includes a transceiver module connected to the processing module. The transceiver module is configured for sending data to and receiving data from the data network.

In still another embodiment, a method of integrating voice and data on a network is provided. The method includes connecting a data module to a key system uni and connecting a data network to the data module. The method also includes providing voice access to the network through the key system and providing data access to the network through the data module.

The invention will next be described in connection with certain exemplary embodiments; however, it should be clear to those skilled in the art that various modifications, additions and subtractions can be made without departing from the spirit or scope of the claims.

Brief Description of the Drawings

The invention will be more clearly understood by reference to the following detailed description of an exemplary embodiment in conjunction with the accompanying drawings, in which:

FIG. 1 depicts a block diagram of a conventional system for combining

data and voice;

FIG. 2 depicts a block diagram of a system for combining voice and data on a network in accordance with the present invention;

FIG. 3 depicts a block diagram of an embodiment of the voice and data switch illustrated in Fig. 1; and

FIG. 4 depicts a block diagram of an embodiment of the data module illustrated in Fig. 3;

FIG. 5 depicts a block diagram of another embodiment of the data module illustrated in Fig. 3;

FIG. 6 depicts a block diagram of a software architecture employed by the voice and data module of Fig. 3.

Detailed Description of the Invention

It will thus be seen that the invention efficiently attains the objects set forth above, among those made apparent from the preceding description. In particular, the invention provides apparatus and methods of integrating voice and data over a network. An integrated system could enable all the capabilities of separate voice and data networks at less expense. Data applications might include Internet / intranet, POS, e-mail, e-commerce, video-conferencing, collaboration and the like. Voice capabilities could include voice features, networking, voice mail, Automatic Call Distribution (ACD), Integrated Voice Response (IVR), CTI and the like.

A difference between the present invention and existing separate voice and data networks, as illustrated in Fig. 1, is that the present invention is accomplished via a single system which reduces the complexities, number of interfaces and costs of procuring, installing and operating separate voice and data systems and components and delivers the benefits of unified network and system management. This is illustrated by comparing Fig. 1 which illustrates a conventional system for combining data and voice with Fig. 2 which illustrates an integrated system in accordance with the present invention. As seen by this comparison, the data module 20 may replace the multiplexor and router of the conventional systems.

In the present invention, the data module 20 may perform the routing functions and the KSU 10 may perform the add/drop multiplexing capabilities. This may result in a savings to the owner of the network in that it is generally cheaper to buy one unit containing all functions rather than separate units for each function. Additionally, if an operator has two separate T1 lines (or fractional T1 lines) to the network (one for voice and one for data) then a cost savings can be realized with the present invention since only 1 T1 line 240 (or one fractional T1 line 240) is needed with the KSU providing the add/drop multiplexing.

Fig. 2 illustrates that the data module 20 may include one or more interfaces for connection to existing data networks 230 (e.g. for connecting standard routers, bridges or hubs, etc.) The interface(s) may be software configurable to comply with different standards (e.g. V.35, EIA-530, EIA-530A, RS-232, RS-449, etc.) and/or to support multiple data rates or there may be different interfaces for different standards and/or data transfer rates, or there may be a combination of configurable and set interfaces. Further, the interface(s) may be synchronous or asynchronous. From the point of view of the data network 230 (i.e. the router or bridge thereof), the data module acts like a data communication equipment (DCE). Alternatively, the data module 20 may be a data interface for connection to existing data networks 230.

Fig. 3 illustrates the voice and data switch 200 of Fig. 2 in greater detail. As seen from Fig. 3, the voice and data switch may include a modified KSU 10 and a data module 20. Data module 20 is connected to KSU 10 by an optical fiber 40. While an optical fiber has been disclosed, one skilled in the art will recognize that any connector which is compatible with the KSU and which is capable of carrying digital data may be employed (i.e. coaxial cable, infra red links, twisted pair, etc.). Additionally, Figs. 2 and 3 illustrate the use of a T1 line 30 for connecting to a PSTN and/or a Data Service provider. While a T1 line is illustrated any digital carrier may be employed such as E1, Dialup Function, Basic Rate Interface (BRI), Primary Rate Interface (PRI) and the like.

In order to share T1 Trunk lines the T1 Trunk module in the KSU (not shown) may be modified to support fractional T1. The T1 Trunk cartridge and KSU software

chosen for this purpose can support up to 24 DS0's (64 kb/s channels). These numbers are intended to be illustrative rather than limiting. It is possible to support more or fewer DS0's and it may be possible or necessary to employ different sized channels. The KSU 10 will perform the multiplexing and demultiplexing of these DS0's; allocating some for voice information and some for data information depending upon the particular requirements of a given installation. It will be apparent to those skilled in the art that DS0's could be allocated dynamically or statically.

Fig. 4 is a more detailed illustration of a data module 20 in accordance with the present invention. As illustrated, the data module may include a microprocessor 60, a repeater 100, network controller 110, and a WAN processor (bridge 120 and/or router 130). While the repeater 100 is illustrated as having 12 ports 50, it will be apparent to one skilled in the art that it could be designed with fewer or additional ports 50. The data module 20 may also include shared DRAM 90, a hardware data compression module option connector (not shown), link status indicators (i.e. LEDs, etc.; not shown), a power supply (not shown), boot PROM 70, Flash RAM 80, and NVRAM (not shown).

The data module 20 illustrated in Fig. 4 may also include a data interface for connecting to a conventional data network 230. The data interface includes an application specific integrated circuit (ASIC) 520 (as illustrated in Fig. 5) or the like (e.g. a microprocessor, field programmable gate array FPGA, etc.). Those skilled will recognize that microprocessor 60 could also be configured to perform the functions of the ASIC 520. In electrical communication with the microprocessor, a clock 550 (Fig. 5) and a transceiver interface 540. The transceiver interface is in electrical communication with a Dsub-26 connector. The operation will be discussed further in connection with the data module illustrated in Fig. 5.

Fig. 5 is a more detailed illustration of a data module 20 in accordance with the present invention wherein the data module 20 is merely a data interface for connection to a data network 230. In the configuration where the data module is a data interface, it may include a fiber interface 500, a microprocessor 510, an ASIC or the like 520, a clock 550, a transceiver interface 540 and a Dsub-26 connector 560. The fiber

interface 500 terminates the optical fiber 40 illustrated in Fig. 3 and includes a fiber transmitter and receiver pair (not shown). It recovers a clock signal from data received from the KSU and provides the clock signal to the ASIC 520 and the microprocessor 510. The fiber interface 500 also provides an interface for the microprocessor 510 to communicate with the KSU 10 and may include input/output (I/O) pins which can be used for system identification or peripheral control. The microprocessor 510 provides the processing power to ensure that the data module 20 serves as a stimulus device to the KSU 10. The microprocessor 510 accepts commands from the KSU, initializes the local hardware, returns queries and events to the KSU, handles maintenance functions and may service interrupts from the transceiver interface 540 related to flow control. The ASIC 520 is in electrical communication with the microprocessor 510 and provides a buffer and mapping between the transceiver interface 540 and the fiber interface 500. The ASIC 520 may also provide functions such as an interrupt controller and a clock divider. The clock 550 is in electrical communication with the ASIC. The ASIC 520 provides the clock signal (or a portion thereof) received from the fiber interface 500 to the clock 550. The clock 550 uses this clock signal to generate clock signals which are used to clock the data. The transceiver interface 540 is in electrical communication with the ASIC 520 and controls the data port 560. The transceiver interface 540 may be configurable to support different standards (e.g., V.35, EIA-530, EIA-530A, RS-232, RS-449, etc.).

The following is a specific embodiment of the invention listing specific parts employed, however, the disclosure of these particular part names and/or numbers is not intended to be limiting in any way. Those skilled in the art will recognize that where specific parts are listed, other conventional parts may be substituted without departing from the scope of the invention.

In an embodiment of the present invention, the data module 20 includes two boards and a modular power supply. While this embodiment is described using two boards, it will be apparent that it could also be configured for one board or three or more boards. The first board supports the fiber interface 40, shared DRAM 90, a hardware data compression (ZipLock module) option connector (not shown), twelve

10Base-T Ethernet repeated ports 50, and led indicators. The second board supports an i960 microprocessor 60, boot PROM 70, Flash RAM 80, NVRAM, and interface logic to the other board. Both of these cards employ two sided, surface mount technology to fit the required functions into a small space.

The microprocessor 60 has been chosen as an i960 since performance is not critical in this device, however, other standard microprocessors could have also been chosen without departing from the scope of the invention..

The 12 10Base-T Ethernet repeater ports 50 are presented on a standard 25-pair key telephone connector (male). The ports conform to the IEEE 802.3 and 802.3u standards which are incorporated herein by reference for the use of Ethernet LAN technology over Unshielded Twisted Pair wiring, running at 10 Mbps. Those skilled in the art will recognize that the ports 50 could also be designed to operate on other types of LANs as well such as Token Ring, 802.4 networks, etc or at other speeds such as 100 Mbps, 1Gbps etc..

The Ethernet circuitry includes a National DP83953 RIC IIA chip for the repeater 100, and a National DP83932 SONIC chip for the network controller 110 and microprocessor system interface. While these particular chips have been disclosed, any suitable conventional repeater or network controller could be employed.

Each of the Ethernet ports 50 could include a Link LED or other suitable indicator connected thereto, which indicates that a link is present on the port 50 or no link is present. A link is defined as the port sensing a valid network signal thereon.

Boot PROM 70 was chosen as a 256K x 8 EPROM to bring the board up into an operable state. Again, other conventional Boot PROMs could have been employed.

Flash RAM 80, has been chosen as 4 Mbytes of configured flash RAM, 32 bits wide, local to the system processor so that CPU code may be run from flash RAM 80.

DRAM 90 has been chosen as 8 Mbyte of DRAM to be shared by the CPU 60, the network controller 110, the WAN controller 120/130 and the ZipLock option board (not shown).

The battery backed SRAM chip (32Kbytes of non volatile (battery backed) SRAM) provides complete functionality for a Real Time Clock. A Watch Dog Timer

may be supported by this device also. A lithium battery with 10 years of life in the absence of VCC may be contained in the chip.

The Siemens Munich32 is used as the HDLC controller 140 due to its sophisticated support for channelized HDLC and it's on board DMA support to system memory.

Channel Control logic presents an 8-bit bus to a microcontroller which is used for communications between the data module 20 and the microprocessor 60. This communications is used to support the interface 40.

The network address PROM 70 may be the Cabletron standard 82S123 (32 x 8). This device may be programmed in increments of two, so 2 MAC addresses may be provided for each board. The first, or lower, MAC address is for the Ethernet side, the second is for the WAN side.

In operation, the integrated voice and data network of the present invention may operate by connecting a local area network server and workstations to the data module 20 through the ports 50. Thus, communications between workstations and between a workstation and the server pass through the data module 20. Telephones, answering machines and other voice devices may be connected to the KSU 10. Both the KSU 10 and the data module 20 may be located in the same housing 200 but are not required to be. The KSU 10 may connect to the PSTN or a private telephone network and/or to a data service provider such as a corporate intranet or the Internet. In any event, the KSU 10 may connect to these voice and data service providers through a common communication carrier 30 such as a T1 line or some other digital line. The KSU 10 divides the bandwidth of the common communication carrier 30 into different channels and depending on the requirements of the system, assigns some channels to voice communications and other channels to data communications. These assignments of channels may be dynamically selected by the KSU 10, they may be set by the system administrator, by the user or they may be factory set.

With regard to voice communications, the KSU 10 operates as a conventional KSU and routes voice messages to the PSTN when necessary. For data messages, the KSU 10 receives messages from the data module 20. An emulator 320 in the KSU 10

communicates with the connection server 310 and accesses a channel reserved by the KSU 10 for data communications. A possible software architecture for performing these functions is illustrated in Figure 6. In Figure 6, each driver 330 (i.e. terminal driver, trunk driver, data module driver, etc.) is associated with a physical device. Each driver 330 also communicates with an emulator 320 (i.e. terminal emulator, trunk emulator, data module emulator, etc.). These emulators 320 may be intelligent (i.e. have knowledge of the system and other emulators in the system) and may communicate with each other to establish connections and provide feature applications over the switch fabric in the KSU 10. While the physical devices, drivers 330 and emulators 320 have been described with one to one correspondences, those skilled in the art will recognize that there is no requirement for such a correspondence. A particular driver 330 could be designed to perform multiple functions as could a particular emulator 320.

For advanced applications such as connection to a WAN or connection to the PSTN, different servers 310 (i.e. connection, DS0, etc.) may be employed to communicate capabilities between emulators 320 and associate data with these emulators 320. Finally, user interface to control the system and parameters therein may go through the operation administration and maintenance (OA&M) interface 300 (also referred to as the management user interface).

The OA&M interface 300 may allow remote management of voice such as connection to a remote site, performing Move Add or Change functions and then disconnecting. It may also allow for remote management of data such as monitoring the network performance and status on an ongoing basis. These management applications may operate over IP with modem dial-up as backup, or simply over modem dial-up. They also may operate via simple network management protocol (SNMP).

It will thus be seen that the invention efficiently attains the objects set forth above, among those made apparent from the preceding description. In particular, the invention provides apparatus and methods for integrating voice and data on a network. Those skilled in the art will appreciate that the configurations depicted in Figures 2-5

are less expensive than conventional systems and are spatially economical as well.

It will be understood that changes may be made in the above construction and in the foregoing sequences of operation without departing from the scope of the invention. It is accordingly intended that all matter contained in the above description or shown in the accompanying drawings be interpreted as illustrative rather than in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention as described herein, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described the invention, what is claimed as new and secured by Letters Patent is:

1. An integrated voice and data network comprising:
a key system unit; and
a data module coupled to said key system unit;
wherein said data module includes:
a microprocessor;
a network controller coupled to said microprocessor;
a multiport repeater coupled to said network controller:
a WAN processor coupled to said repeater and configured to communicate data received from said repeater to said key system unit; and
a data interface coupled to said microprocessor.

2. A network according to Claim 1 wherein said data interface comprises:
a controller in electrical communication with said microprocessor; and,
a transceiver interface in electrical communication with said controller;
wherein said transceiver interface has a port configured for connection to data network equipment.

3. The integrated network according to Claim 1 wherein said WAN processor comprises a bridge.

4. The integrated network according to Claim 1 wherein said WAN processor comprises a router.

5. The integrated network according to Claim 1 wherein:
said data module is coupled to said key system unit via at least one cable capable of transporting digital signals;
and said network controller is an Ethernet controller.

6. The integrated network according to Claim 1 further comprising:

a high-level data link control controller coupled to said microprocessor.

7. The integrated network according to Claim 3 wherein said data module further comprises:

a router coupled between said repeater and said key system unit.

8. A data module comprising:

a media interface;

a processor in electrical communication with said media interface; and

a transceiver interface in electrical communication with said processor;

wherein said transceiver interface has a port configured for connection to data networking equipment.

9. A data module according to Claim 8 wherein said processor includes:

a microprocessor; and

a controller in electrical communication with said microprocessor.

10. A data module according to Claim 9 further comprising a clock coupled to said controller.

11. A data module according to Claim 9 wherein said controller is in electrical communication with said media interface.

12. A data module according to Claim 8 wherein said media interface comprises a fiber transmitter and a fiber receiver.

13. A data module according to Claim 9 further comprising:

a high-level data link control controller coupled to said microprocessor.

14. A data module according to Claim 8 wherein said port comprises a data network interface which is selectively configurable to comply with different networking standards.

15. A data module according to Claim 14 wherein said different networking standards include a standard selected from the group consisting of V.35, EIA-530, EIA-530A, RS-232, and RS-449.

16. A data module according to Claim 14 wherein said data network interface is an asynchronous interface.

17. A data module according to Claim 14 wherein said data network interface is a synchronous interface.

18. A data module according to Claim 14 wherein said data network interface is configurable to operate at a plurality of data transfer rates.

19. A data module according to Claim 18 wherein said data network interface is configurable to operate at one of a plurality of data transfer rates.

20. A data module according to Claim 18 wherein said port comprises a plurality of data network interfaces.

21. A data module according to Claim 20 wherein ones of said plurality of data network interfaces are selectively configurable to comply with different networking standards.

22. A data module according to Claim 20 wherein:
at least one of said plurality of data network interfaces is configured to comply with one of a plurality of networking standards

at least one other of said plurality of data network interfaces is configured to comply with another one of said plurality of networking standards.

23. A data module capable of connecting a data network to a key system unit, comprising:

coupling means for coupling to a communication medium;

processing means, coupled to said coupling means, for processing data; and

transceiver means coupled to said processing means for sending data to and receiving data from said data network.

24. A data module according to Claim 23 wherein said coupling means comprises a fiber coupler.

25. A data module according to Claim 23 further comprising:

data network interface means in electrical communication with said transceiver means, for selectively coupling to data networking equipment.

26. A data module according to Claim 25 wherein said data network interface means is selectively configurable to comply with different data network standards.

27. A data module according to Claim 25 wherein said data network interface means is an asynchronous interface.

28. A data module according to Claim 25 wherein said data network interface means is a synchronous interface.

29. A data module according to Claim 23 wherein said processing means includes a microprocessor and a controller in electrical communication with said microprocessor and said coupling means.

30. A method of integrating voice and data on a network comprising:
connecting a data module to a key system unit;
connecting a data network to said data module;
providing voice access to said network through said key system; and
providing data access to said network through said data module.

31. A method of integrating voice and data on a network according to Claim 30 further comprising communicating data between said data network and said key system unit.

32. A method of integrating voice and data on a network according to Claim 30 further comprising selectively configuring said data module to be compatible with said data network.

33. A method of integrating voice and data on a network according to Claim 30 wherein said connecting a data module to a key system unit is performed using a fiber cable.

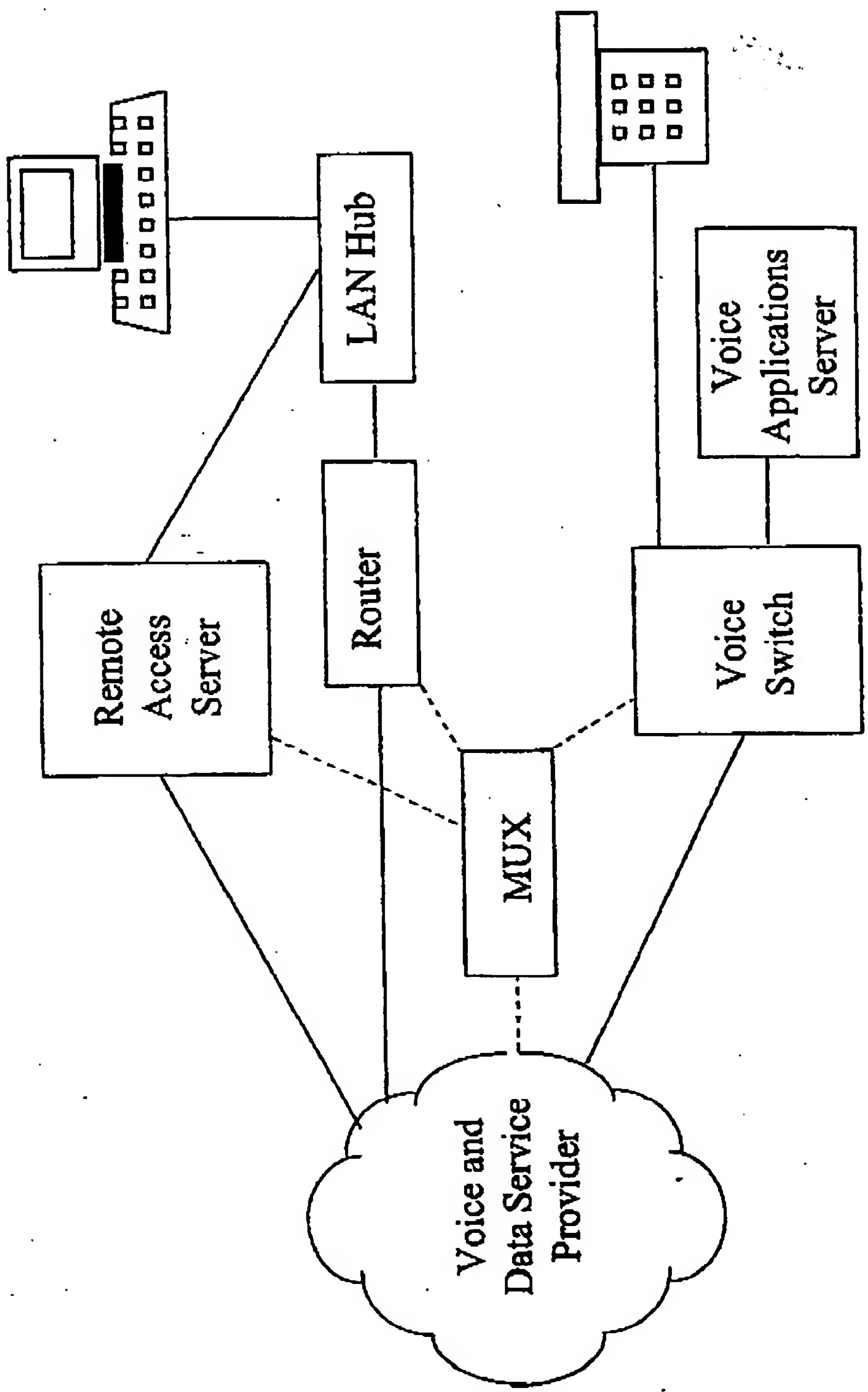

LAN Hub
Router
Remote Access Server
Voice Applications Server
Voice Switch
MUX
Voice and Data Service Provider

FIG. 1

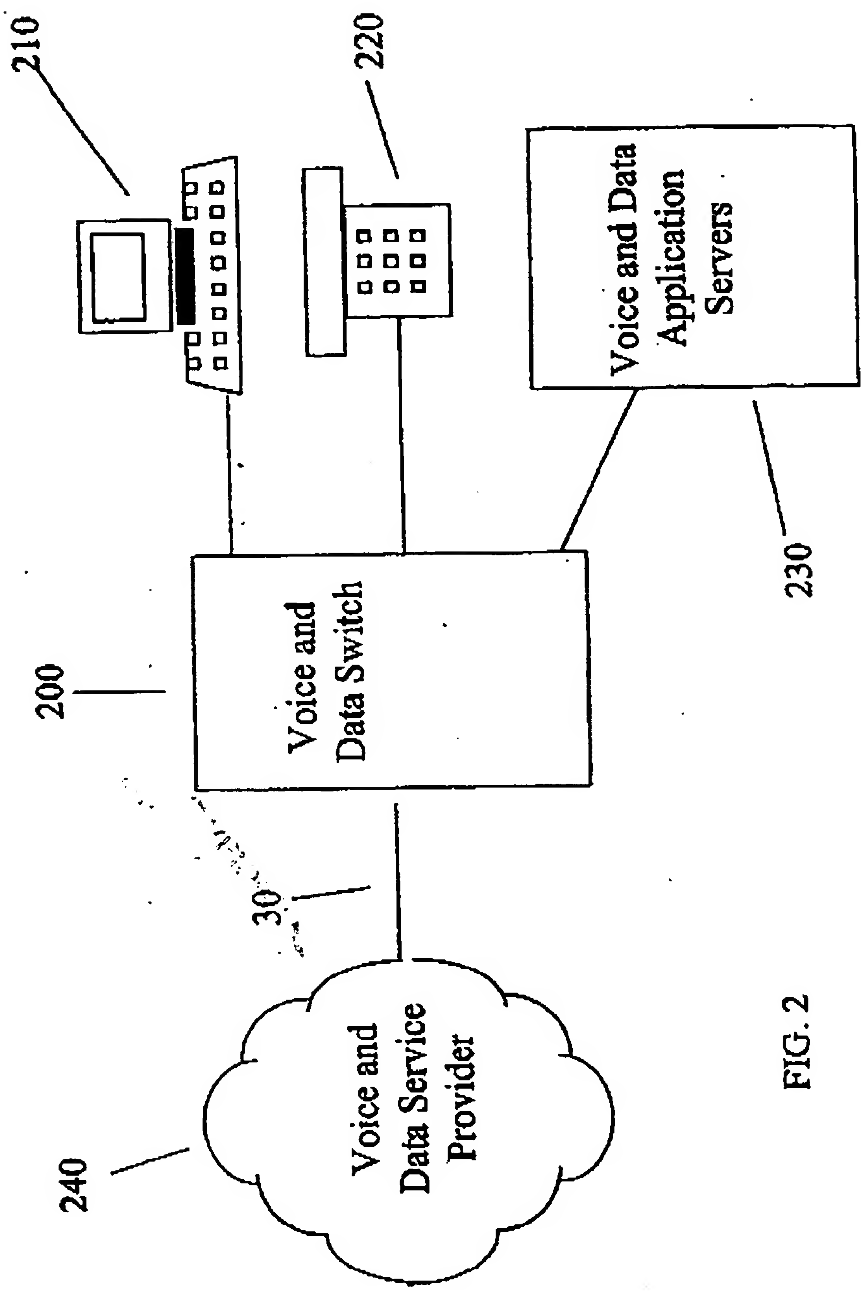

210
220
Voice and Data Application Servers
230
200
Voice and Data Switch
30
Voice and Data Service Provider
240

FIG. 2

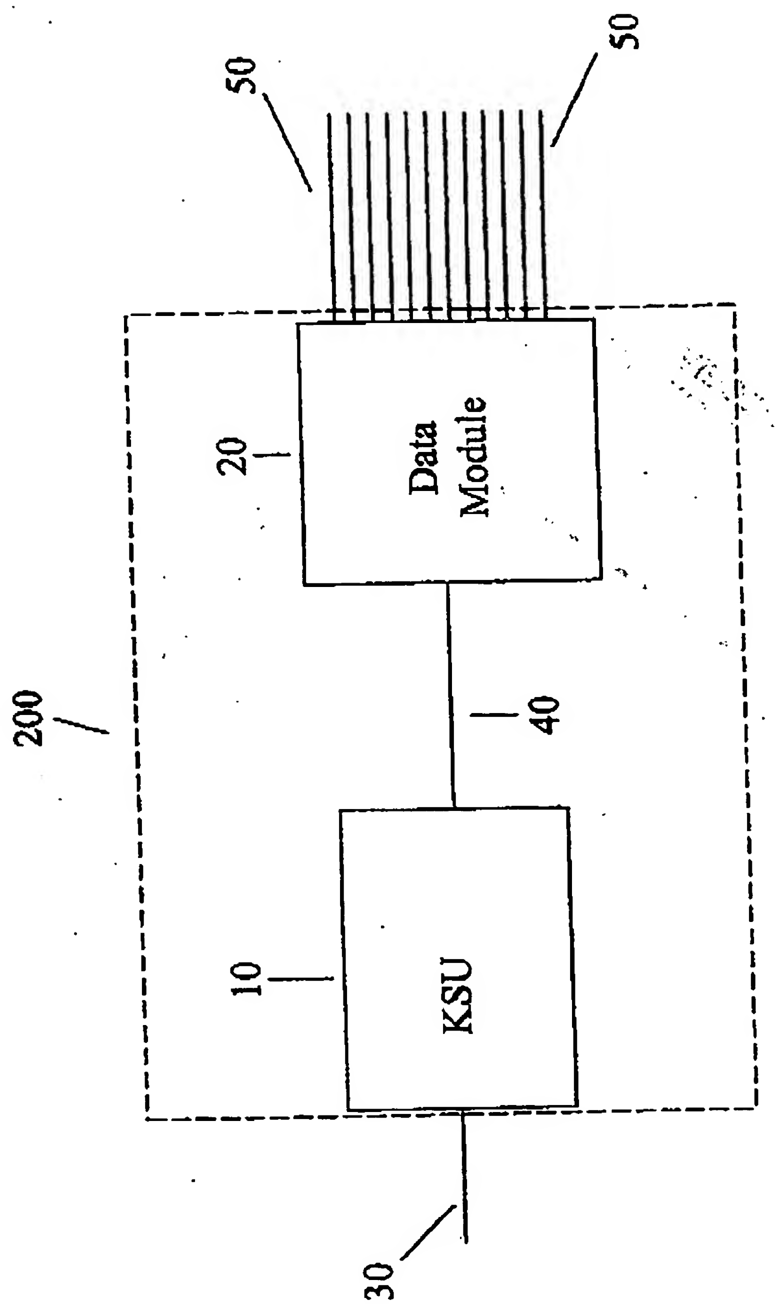


FIG. 3

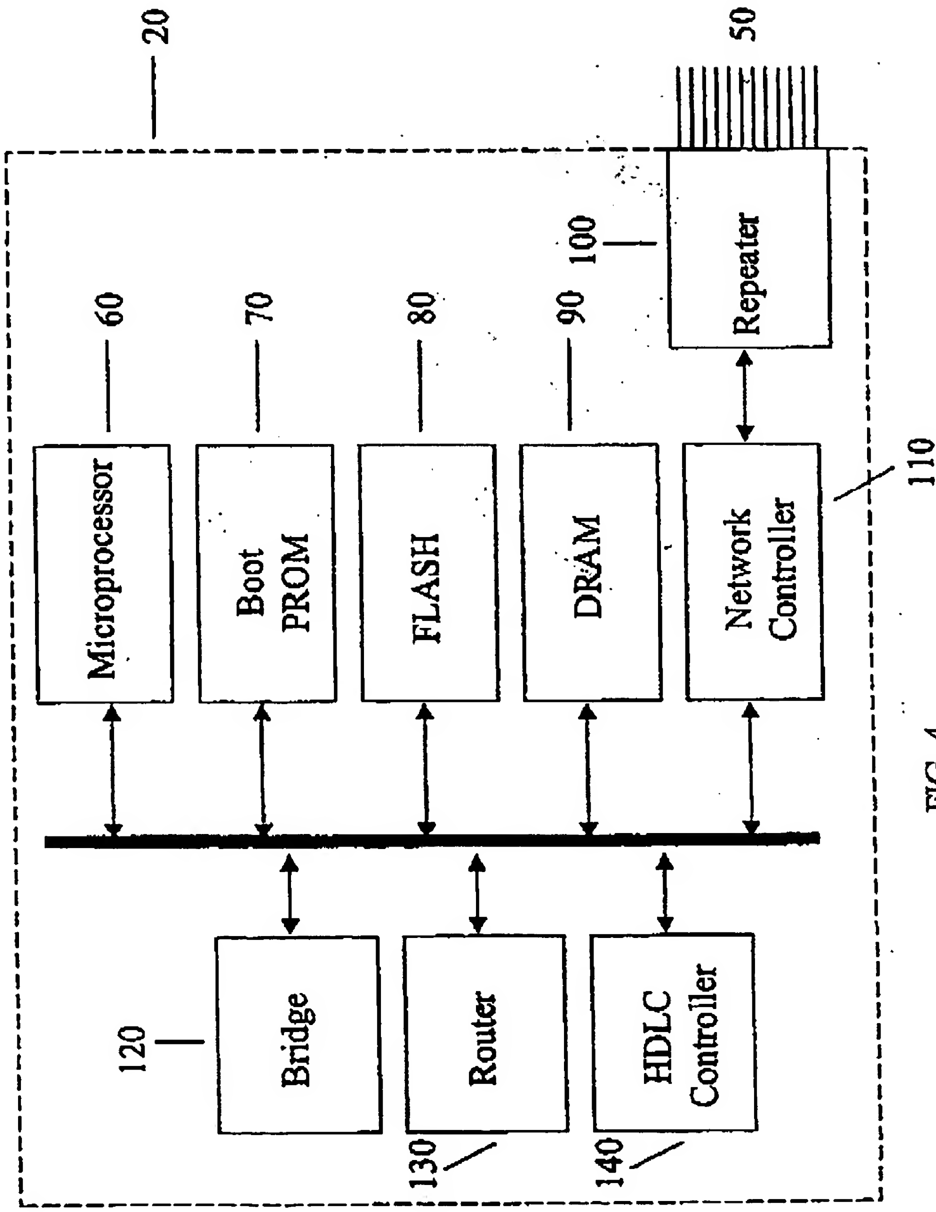

20
50
100
Repeater
60
70
80
90
Microprocessor
Boot PROM
FLASH
DRAM
Network Controller
110
120
Bridge
Router
HDLC Controller
130
140

FIG. 4

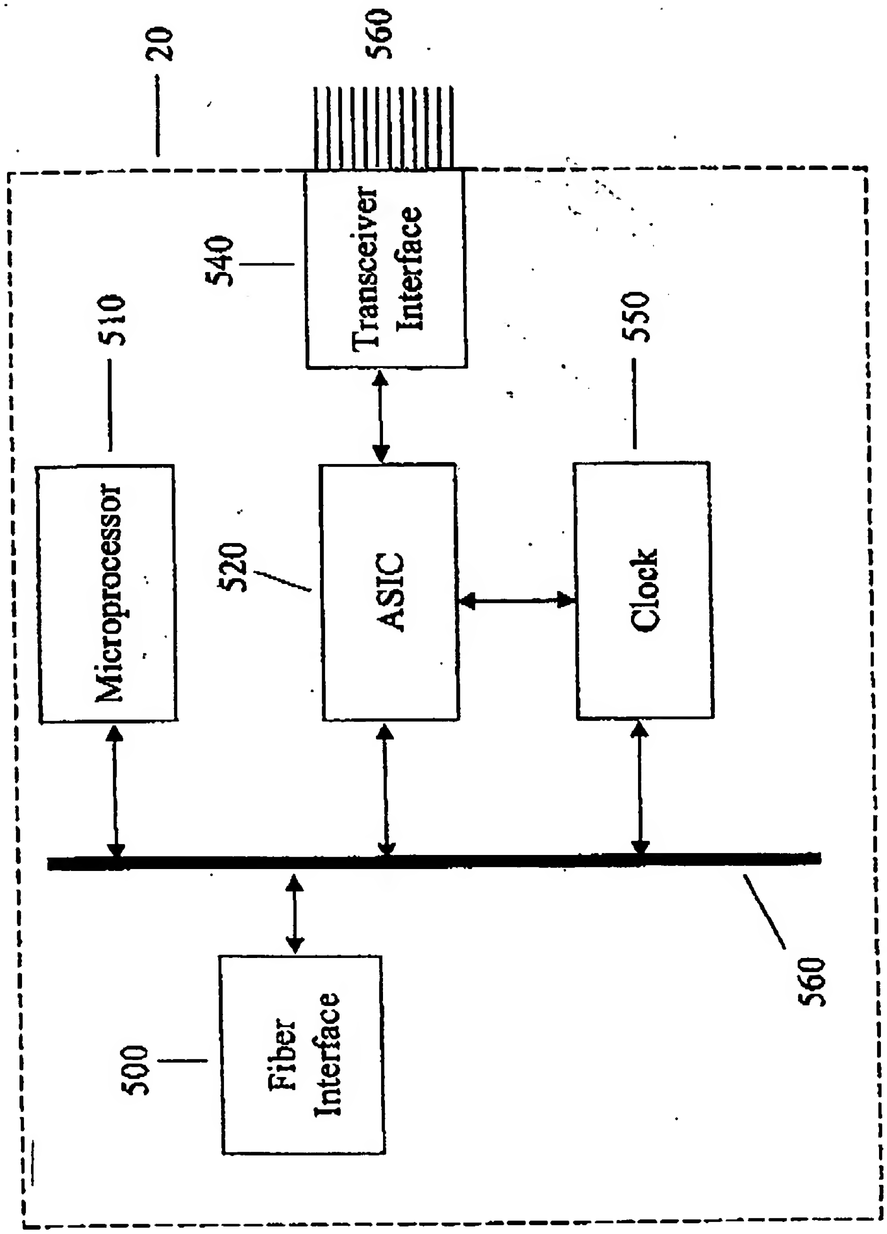
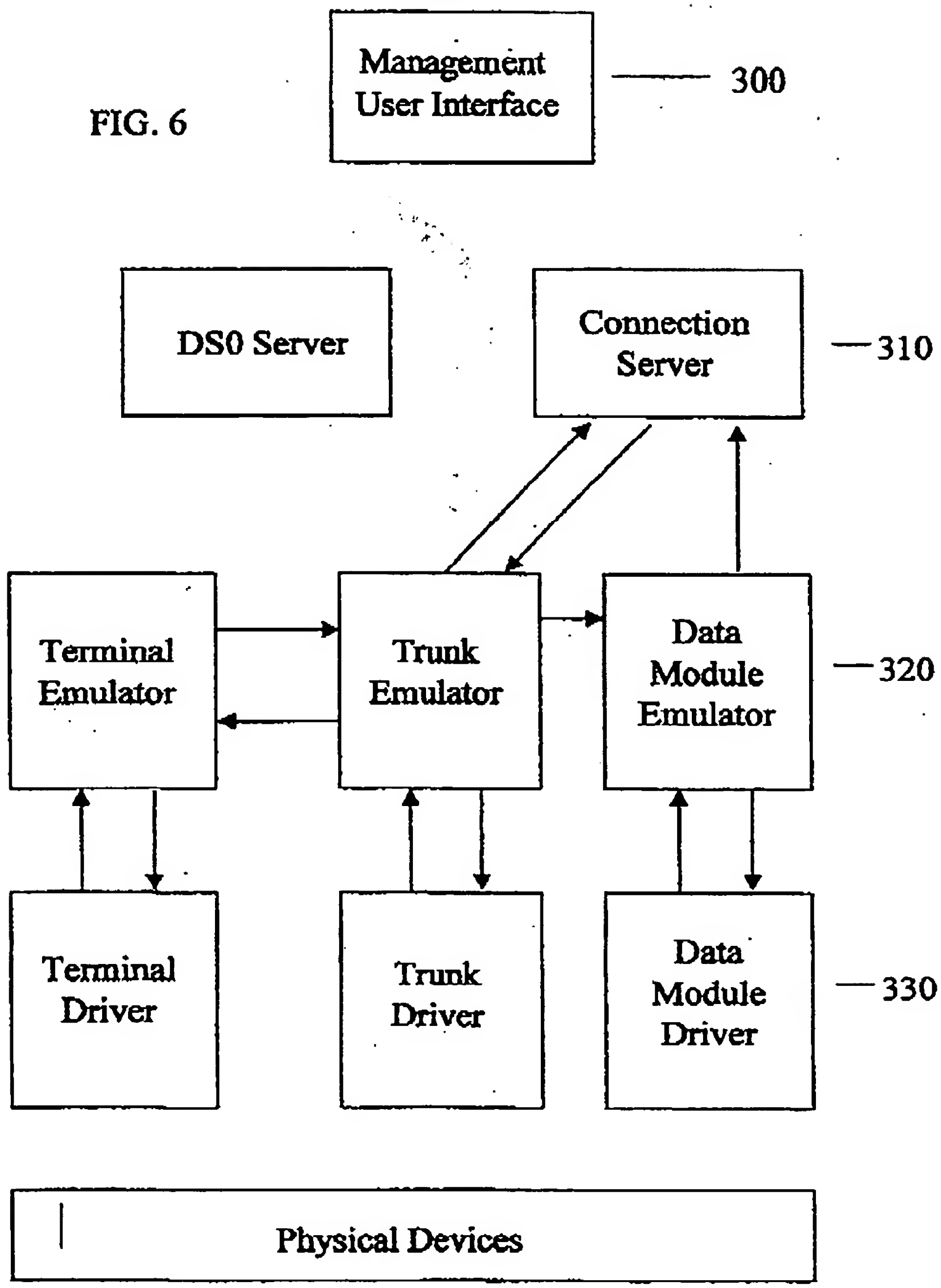

20
560
540
Transceiver Interface
510
550
Microprocessor
520
ASIC
Clock
560
500
Fiber Interface

FIG. 5

FIG. 6


Management User Interface
300
DS0 Server
Connection Server
310
Terminal Emulator
Trunk Emulator
Data Module Emulator
320
Terminal Driver
Trunk Driver
Data Module Driver
330
Physical Devices